PATENT SPECIFICATION

DRAWINGS ATTACHED

851,192

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COMPLETE SPECIFICATION

Improvements in Textile Fabrics

We, UNITED STATES RUBBER COMPANY, of Rockefeller Centre, 1230 Avenue of the Americas, New York, State of New York. United States of America, a corporation organized and existing under the laws of the State of New Jersey, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to textile fabrics and to a method of making the same.

It is known that textile fabrics can be made in which two groups of yarns, having relatively different lengthwise shrinkage characteristics, are arranged in parallel. Yarns from the several groups are tied together at points spaced apart along the length of these yarns, and intermediate the points the yarns are relatively free of each other.

For example, a fabric may be woven with either a warp or a weft which includes relatively shrinkable and non-shrinkable yarns. Tying orthogonal yarns interlace with both the more shrinkage and the less shrinkable yarns at intervals spaced apart along the length of the more shrinkable and less shrinkable yarns. After the yarns have been interlaced to form the fabric, the fabric is subjected to a treatment which will shrink the more shrinkable yarns. The shrinkage of the more shrinkable yarns causes the less shrinkable yarns to buckle in the distance between the tying orthogonal yarns which are interlaced with both the more shrinkable and the less shrinkable yarns.

Intermediate these tying orthogonal yarns, which interlace with both the more and the less shrinkable yarns, other orthogonal yarns customarily are used which interlace only with the more shrinkable yarns or only with the less shrinkable yarns. Thus several plans of interlacing the intermediate orthogonal yarns are used. For example. the intermediate orthogonal yarns may interlace only with the more shrinkable yarns. Upon shrinkage of this fabric, each individual less shrinkable yarns is buckled independently of the othen less shrinkable yarns, and a fabric is produced which might be characterized as a loop pile fabric immediately after the shrinking treatment. Or the intermediate orthogonal yarns may be interlaced only with the less shrinkable yarns so the individual less shrinkable yarns are tied together by these orthogonal yarns, and upon shrinking of the more shrinkable yarns, both the less shrinkable yarns and the intermediate orthogonal yarns will be displaced upon shrinking of the more shrinkable yarns to produce a fabric which might be characterized as a "blister" fabric after the shrinking treatment. Or one group of intermediate orthogonal yarns may interlace only with the less shrinkable yarns, and another group of intermediate orthogonal yarns may interlace only with the more shrinkable orthogonal yarns. Such a fabric after shrinking may also be characterized as a "blister" fabric.

A great variety of patterns can be produced embodying this principle by suitably varying the plan on which the several yarns are interlaced. For example, a given group of orthogonal yarns may interlace only with either the more shrinkable yarns or the less shrinkable yarns in one zone along their length, and in the succeeding zone along their length the orthogonal yarns may interlace with both the more shrinkable yarns and the less shrinkable yarns. In this manner, any given orthogonal yarn may serve as an intermediate orthogonal yarn in one zone along its length whereas in another zone along its length, it may serve as a tying orthogonal yarn to tie the more shrinkable yarns and the less shrinkable yarns together. Also, the more shrinkable yarns and the less shrinkable yarns may be tied together by a plurality of tying orthogonal yarns, so intermediate two buckled areas there is a flat space of considerable length in the direction of the more shrinkable yarns in the fabric.

This invention relates to fabrics of this

type in which the zones in which the more shrinkable yarns are tied to the less shrinkable yarns include a substantial number of orthogonal yarns between the areas where the less shrinkable yarns are buckled. In such fabrics, the more shrinkable yarns must continue between the buckled areas, but since the more shrinkable yarns are required to shrink primarily beneath the areas where the less shrinkable yarns are buckled, the shrinkage of the more shrinkable yarns in the spaces between these buckled areas is not needed to achieve the effect desired in a fabric.

Shrinkage of the more shrinkable yarns in the spaces between the buckled areas is disadvantageous. First, since lengthwise shrinkage of these yarns is accompanied by a swelling of the yarns, shrinkage in these spaces increases the weight of the finished fabric. Second, shrinkage of the more shrinkable yarns in these spaces decreases the overall length of the finished fabric which can be produced from a given length of fabric off-the-loom.

This invention contemplates a novel fabric in which the shrinkage of the more shrinkable yarns is restrained in the spaces between the buckled areas, yet in which these yarns shrink at the buckled areas to achieve the desired fabric on finishing.

In accordance with this invention, this is achieved by so interlacing the more shrinkable yarns with the tying orthogonal yarns in the spaces between the buckled areas that the ratio of the sum of the diameters of the more shrinkable and tying orthogonal yarns in a unit length of fabric, measured in the direction of the more shrinkable yarns, to that unit length of fabric falls in a range of from 0.70 to 1.00 between the buckled areas, and the sum of the diameters of the more shrinkable yarns, and the sum of the diameters of the intermediate orthogonal yarns (if any), at the buckled areas, per unit length of fabric falls beneath 0.60 at the buckled areas. When a fabric is constructed in this manner, the shrinkage of the more shrinkable yarns in the spaces between the buckled areas is restrained, yet these yarns at the buckled areas are free to shrink to cause the desired buckling.

For a better understanding of the nature of this invention, reference should be had to the following detailed description of specific embodiments thereof, when read in conjunction with the accompanying drawings forming a part hereof, wherein:

Fig. 1 is a plan view of one embodiment of a finished fabric in accordance with this invention;

Fig. 2 is a cross-sectional view of the fabric of Fig. 1 along the line 2—2 looking at a shrinkable yarn;

Fig. 3 is a view of the fabric of Fig. 1 similar to Fig. 2, but showing the fabric as it comes from the loom and before it is shrunk;

Fig. 4 is a partly schematic view of the reverse side of the fabric of Fig. 1 showing a characteristic distortion of the orthogonal yarns which occurs in the fabrics in accordance with this invention at the edges of the flat spaces, and

Fig. 5 is a weave plan for the fabric of Fig. 1 showing a half repeat in the warp and a full repeat in the weft.

Referring now to the drawings, there is shown a fabric of the so-called "blister" type. As shown, the fabric has a multiplicity of buckled areas or "blisters" 10 uniformly spaced about the surface of the fabric in a checker-board pattern. Between the buckled areas 10, the fabric is flat in the spaces 11. This is best illustrated in Fig. 2 where the two blisters 10 are shown separated by a flat space 11.

In the now preferred embodiments, the fabrics are woven, and they are constructed so that shrinkage occurs in the warp direction only. However it will be readily apparent to those skilled in the art that woven fabrics can be constructed so that they are shrunk in the filling direction only, and in that case the more shrinkable yarns will extend in the filling direction only. It will also be recognized that if desired the more shrinkable yarns can extend in both the warp and the filling direction.

The fabric shown in the drawings, comprises the more shrinkable warps 12 and the less shrinkable warps 13. Two systems of wefts are employed; a first system includes the wefts 14 which interlace only with the less shrinkable warps 13 at the buckled areas 10. The second system of wefts comprise the yarns 15 which interlace only with the more shrinkable yarns 12 at the buckled areas 10. In the flat spaces 11, the more shrinkable yarns 12 and the less shrinkable yarns 13 interlace with both groups of filling yarns 14, 15 so the less shrinkable yarns 13 and the more shrinkable yarns 12 are tied together by the interlacing of the fabric in the flat spaces 11. Since at the buckled areas 10, the more shrinkable yarns 12 do not interlace with the yarns 14, the less shrinkable yarns 13 are free to buckle upon shrinkage of the yarn 12 to produce the buckled areas 10.

In a blister fabric such as that shown, the less shrinkable yarns 13 and the orthogonal yarns 14, and the manner in which these yarns are interlaced, desirably are such that a blister is produced which is capable of resiliently resisting compression.

It will be apparent from a consideration of Figs. 2 and 3, that the more shrinkable yarns 12 extend throughout the length of the fabric and thus through both the buckled areas 10 and the flat spaces 11 between

the buckled areas. When the fabric is subjected to the shrinking treatment, the more shrinkable yarns 12 will tend to shrink in both the buckled areas 10 and the flat spaces 11, though shrinkage in the flat spaces 11 is not essential to produce the desired buckled effect, and shrinkage at these flat spaces shortens the length of the finished fabric and increases its weight.

In accordance with this invention, shrinkage of the more shrinkable yarns 12 is restrained at the flat spaces 11, and the more shrinkable yarns 12 are free to shrink at the buckled areas 10 to produce the desired buckling of the less shrinkable yarns 13.

This is achieved by so interlacing the shrinkable yarns 12 with the tying orthogonal yarns, in the embodiments shown those portions of yarns 14 and 15 which are situated at the flat spaces 11, in the flat spaces between the buckled areas, that the ratio of the sum of tying orthogonal yarn diameters plus the sum of the shrinkable yarn diameters in a given length of the fabric off-the-loom to that length of fabric falls in the range of .70 to 1.00 in the spaces between the buckled areas, and the similar ratio of the sums of the diameters of yarns 12 and 15 at the buckled areas falls below .60.

In determining this ratio, which is hereinafter referred to as the "tightness index" in the specification and the appended claims, the following procedure is followed.

First, the diameter of a yarn is computed by first determining the number of yards per pound in the yarn under consideration. Extract the square root of this number. Divide this square root into 1.0 to express the diameter of the yarn in inches. This diameter is corrected for the fuzziness of the yarn and for the air spaces within the yarn by multiplying this diameter by the appropriate correction factor from the following table to obtain a more accurate diameter:

Type Yarn	Correction Factor
Twisted Multi-filament	1.04
Spun synthetic	1.07
Cotton	1.09
Worsted	1.11
Woollen	1.19
Monofilaments	1.00

Thus, if a yarn is spun from cotton so that it has 3660 yards per pound, its diameter is:

$$\frac{1.09}{\sqrt{3660}} = 0.018 \text{ inch}$$

Second, a particular part of the fabric is selected, i.e. a flat area 11 or a buckled area 10. The number of orthogonal yarns which interlace with the more shrinkable yarns in this part of the fabric is counted.

Third, the number of orthogonal yarns which are counted are multiplied by their respective diameters to obtain a summation of orthogonal yarn diameters. For example, a flat space 11, 0.50 inch long, might contain 6 orthogonal yarns of .018 inches diameter and 8 orthogonal yarns of 0.20 inches diameter. Total diameters would then be:

$$6 \times .018 + 8 \times .020 = .268 \text{ inch}$$

Fourth, the number of more shrinkable yarn diameters in this part of the fabric is computed as follows. Every time a more shrinkable yarn passes up or down between the orthogonal yarns, it is considered an interlacing. The number of interlacings is counted and this is considered the number of more shrinkable yarn diameters. Thus in the case of a plain weave, there will be just as many interlacings as there are orthogonal yarns, and in the case of a 2×2 twill there will be half as many interlacings as there are orthogonal yarns.

Fifth, the sum of the more shrinkable yarn diameters is computed in the same way that the sum of orthogonal yarn diameters is computed. For example, if a 10 mill polyethylene is used with 10,000 yards per pound in a plain weave at a spacing of 20 orthogonal yarns per inch, in any section of the fabric the more shrinkable yarns would interlace at the rate of 20 interlacings per inch, each with an effective diameter of 0.010 inches. Therefore, the rate of total diameters per inch of fabric would be

$$20 \times .010 = 0.20 \text{ inches/inch of fabric.}$$

If the space 11 considered is 0.50 inches long, the sum of more shrinkable yarn diameters in this space is

0.20 inches/inch × 0.50 inches = 0.10 inches.

The tightness index of the part of the fabric selected is computed by (1) calculating the sum of (a) orthogonal and (b) more shrinkable yarn diameters, (2) adding these two sums together to get a summation of orthogonal and more shrinkable yarn diameters all as specified in the preceding five paragraphs, and (3) dividing this summation by the length of that part of the fabric selected.

In the case of examples given in the five paragraphs preceding that next above, the tightness index would be

$$\frac{.268 \text{ inches} + 0.10 \text{ inches}}{0.50 \text{ inches}} = 0.736.$$

This is the ratio of effective diameters of yarns in a flat space 11 to the length of that flat space along the fabric measured in the direction of the more shrinkable yarn. This ratio for the foregoing example is above 0.70, and we have found that the shrinkage of the more shrinkable yarn would be appreciably inhibited in such a construction.

We have found that in addition to having a high tightness index in the areas of restricted shrinkage and a low tightness index in the buckled areas, it is necessary to have the more shrinkable yarns frequently interlaced with the orthogonal yarns in the flat spaces between the buckled areas. The more shrinkable yarns should interlace and tie down with the orthogonal yarns once at least every four orthogonal yarns. and preferably at the rate of at most three and one-half orthogonal yarns per interlacing, or be interlaced with the orthogonal yarns at the rate of at least 6 interlacings per inch and preferably at the rate of at least 10 interlacings per inch of flat space.

The following specific embodiments serve further to illustrate this invention. In these tables, all the data given, except for the two items which state the percent shrinkage, is taken from the fabric in the greige state as it comes from the loom.

TABLE I

Flat Spaces (Restricted)	1	2	3
1. Type Filling "A"	900 Den. Viscose	8/2 Spun Viscose	8/2 Spun Viscose
2. Picks per inch of "A"	26	15.75	31.5
3. Diameter of "A" (inches)	0.0147	0.01845	0.01845
4. Sum of "A" diameter (inches per inch)	0.573	0.290	0.580
5. Type Filling "B"	6.75/1 Cotton	3/1 Spun Acetate	—
6. Picks per inch of "B"	13	15.75	—
7. Diameter of "B" (inches)	0.01425	0.2130	—
8. Sum of "B" diameters (inches per inch)	0.185	0.335	—
9. Total of all Filling Diameters (item I, 4 plus item I, 8)	0.758	0.625	0.580
10. Type Warp "C" (shrinkable)	12 Mil Polyethylene	10 Mil Polyethylene	10 Mil Polyethylene
11. Interlacings of "C" per inch	13	15.75	15.75
12. Diameter of "C" (inches)	0.012	0.010	0.010
13. Sum of "C" Diameters (inches per inch)	0.156	0.158	0.158
14. Tightness Index (item I, 9 plus item I, 13 divided by one inch)	0.914	0.783	0.738
15. Shrinkage Yarn ("C") (a) Interlacings per inch with face	13	15.75	15.75
(b) Average picks per interlacing	3	2	2

TABLE II

% Shrinkage (flat spaces)	5	10	12

TABLE III

Buckled Area	1	2	3
1. Type Filling "F"	6.75/1 Cotton	8/2 Spun Viscose	8/2 Spun Viscose
2. Picks per inch of "F"	13	15.75	15.75
3. Diameter of "F" (inches)	0.01425	0.1845	0.1845
4. Sum of "F" Diameters (inches per inch)	0.185	0.290	0.290
5. Type Filling "G"	—	3/1 Spun Acetate	—
6. Picks per inch of "G"	—	15.75	—
7. Diameter of "G" (inches)	—	0.2130	—
8. Sum of "G" Diameters (inches per inch)	—	0.335	—
9. Type Warp "H"	12 Mil Polyethylene	10 Mil Polyethylene	10 Mil Polyethylene
10. Interlacings of "H" (per inch)	13	15.75	15.75
11. Diameter of "H" (inches)	0.012	0.010	0.010
12. Sum of "H" Diameters (inches per inch)	0.156	0.158	0.158
13. Tightness Index (item III, 12 plus item III, 4 or item III, 8 divided by one inch	0.341	0.448* 0.493*	0.448
14. Shrinkable Yarn ("H") (a) Interlacings per inch with face	4.3	3.2	4.0
(b) Average Picks per Interlacing	6.1	5.0	4.0

TABLE IV

% Shrinkage (buckled areas)	36	20	18

* In some areas, the shrinkable yarn, interlaces with the Viscose filling, and in other areas, it interlaces with the Acetate filling.

Example 1 of the foregoing table is the specific embodiment shown in the drawing. For all examples, warp "C" and warp "H" is in fact the same yarn and corresponds to yarn 12; the letter "C" was selected to designate this yarn in the flat space 11 and the letter "H" to designate it at the buckled area 10. In example 1, filling "B" and "F" correspond to yarns 15 in the flat and buckled areas and filling "A" corresponds to yarns 14 in the flat areas.

It will be seen from the above specific embodiments, that with a tightness index in the range of 0.70 to 1.00, the shrinkage is inhibited, and that with a tightness index below 0.60 the more shrinkable yarns shrink to cause the desired buckling. We have found that when this tightness index is reduced below approximately 0.70, the amount of shrinkage in the flat spaces and the buckled areas is approximately equal. It will also be seen that when there are less than 3.5 orthogonal yarns per interlacing, item I, 15 (b), the shrinkage is inhibited. and when there are more than 4.0 orthogonal yarns per interlacing, item III, 14 (b), the more shrinkable yarns shrink to cause the desired buckling. Also, preferably there should be at least six orthogonal yarns in each space of restricted shrinkage.

In Fig. 5 of the drawing, a weave plan for Example 1 of the foregoing table is given. This plan shows a half repeat of the weave in the warp, and a full repeat in the weft. This is a commonly used method for designating a weave, and can be used by one skilled in the art to reproduce this type of fabric. In this plan, the X marks indicate the points at which the warp yarn 13, which is 260 denier nylon, is lifted during weaving, and the solid mark indicates the point when the more shrinkable warp 12 is lifted. The blanks indicate the points where the filling 14 is crossed over a warp yarn, and the circles indicate the points where the filling 15 is crossed over a warp yarn.

In Fig. 4 of the drawing the reverse of the fabric of Fig. 1 is shown. In this figure, the flat spaces 11 and buckled areas 10 have been outlined in broken lines forming squares which represent the shape of the various areas. The orthogonal yarns 15 have been sketched in on these squares. It will be noted that in general the orthogonal yarns 15 extend straight across the fabric as occurs in weaving. However the orthogonal yarns 15^1 which are disposed at the edges of both the buckled and the flat areas are disposed along a tortuous path. Thus considering the flat area 11^1, it will be noted that the upper orthogonal yarn 15^1 at its upper edge is bowed upwardly, and the orthogonal yarn 15^1 at its lower edge is bowed downwardly. Since shrinkage occurred in a direction at right angles to the orthogonal yarns 15, 15^1, this bowing, which can be seen in the fabric, shows clearly that shrinkage was inhibited in the flat areas 11 and it was not inhibited in the buckled areas 10.

Many yarns are well known in the textile art which are suitable for the fabrics of this invention. It is preferred to use heat shrinkable thermo-plastic yarns for the more shrinkable yarns 12. Examples of suitable heat shrinkable yarns are polyethylene (an oriented polymerized ethylene), Vinyon (Registered Trade Mark) (a copolymer of 88—90% vinyl chloride with 10—12% vinyl acetate), Rhovyl (Registered Trade Mark) (polyvinyl chloride), and a Saran (Registered Trade Mark)—the so-called high shrink type (a copolymer of vinyl chloride and vinylidene chloride). When such heat shrinkable yarns are used, the orthogonal yarns 14 and 15 may be yarns which possess the same or different shrinkage characteristics, and the yarns 13 may be non-shrinkable yarns or yarns which shrink less than the yarns 12 under the finishing shrinking treatment. Examples of yarns suitable for the yarns 13, 14 and 15. are cotton, rayon, acetate, nylon, Saran (the so-called low shrink type), polyester fibers, acrylic fibers.

Many of the heat-shrinkable yarns are capable of shrinking 50% or more under the influence of heat and, if this full shrinkage is not necessary to produce the buckling desired, the shrinkage of the fabric can be controlled by feeding a predetermined length of fabric into a heating zone, and by regulating the rate of withdrawal of this fabric to permit the fabric to shrink the desired amount in the heating zone. Desirably, the shrinkage of these fabrics should be controlled so that they shrink 10% or more during the heating cycle.

Yarns other than heat shrinkable yarns can be used for the more shrinkable yarns 12. Thus a nylon yarn might be used for the shrinkable element, in which case the fabric would be treated in a 5% solution of phenol in water, to achieve the shrinkage. In such fabrics, the less shrinkable yarns 13 would necessarily be selected of fibers which did not shrink during the shrinkage treatment, or which shrunk to a lesser extent than the more shrinkable yarns 12 during this treatment.

WHAT WE CLAIM IS:—

1. A fabric comprising first yarns and second yarns extending in the same direction in the fabric, said first yarns shrinking an amount different from said second yarns under a given shrinking treatment, tying yarns interlaced with both said first and second yarns at zones extending along their length to tie said first and second yarns together at said zones. said zones being spaced apart along the lengths of said first and second yarns, said first and second yarns being free of each other at a zone intermediate the zones

where said first and second yarns are tied together whereby yarns which are less shrinkable may buckle when the fabric is shrunk by said given shrinking treatment, said fabric having a tightness index greater than 0.70 off-the-loom measured along the length of a more shrinkable yarn being one of said first or second yarns at the zones where said first and second yarns are interlaced with said tying yarns.

2. A fabric according to claim 1 which has a tightness index less than 0.60 in the zone where said yarns are free of each other.

3. A fabric according to claim 1, wherein said first yarns are heat shrinkable thermoplastic yarns which shrink an amount more than the said second yarns under a given shrinking treatment, the number of tying yarns per interlacing of said heat shrinkable thermoplastic yarns being less than 4.0 at said zones.

4. A fabric substantially as hereinbefore described and illustrated in the accompanying drawings.

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Agent for the Applicants.

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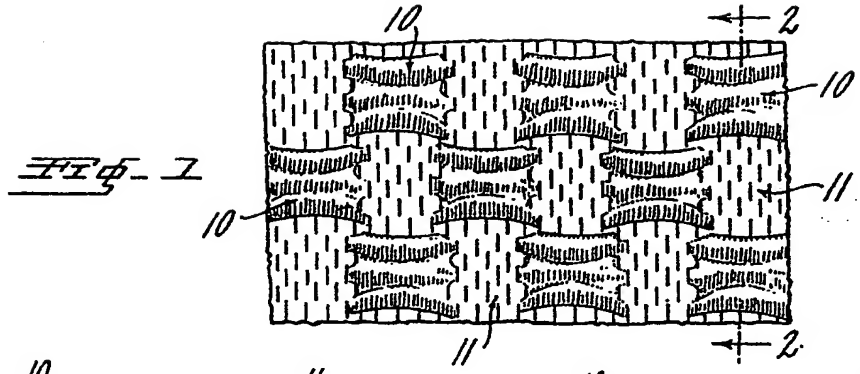

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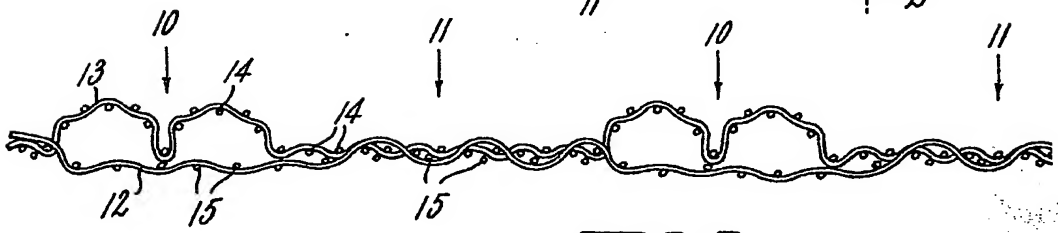

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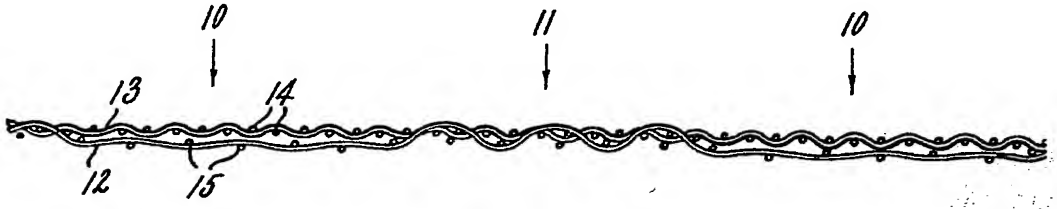


Фиг. 3

851,192 COMPLETE SPECIFICATION
1 SHEET

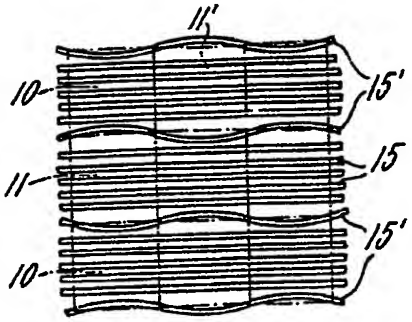
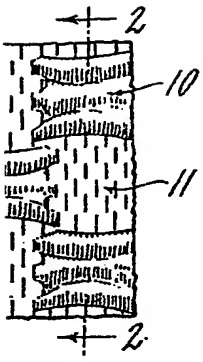
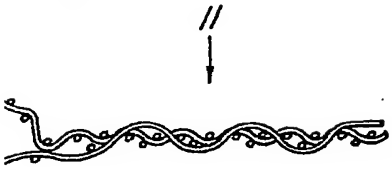
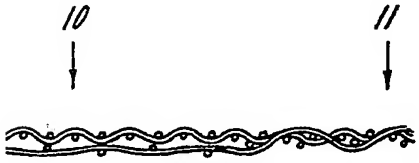


FIG. 4







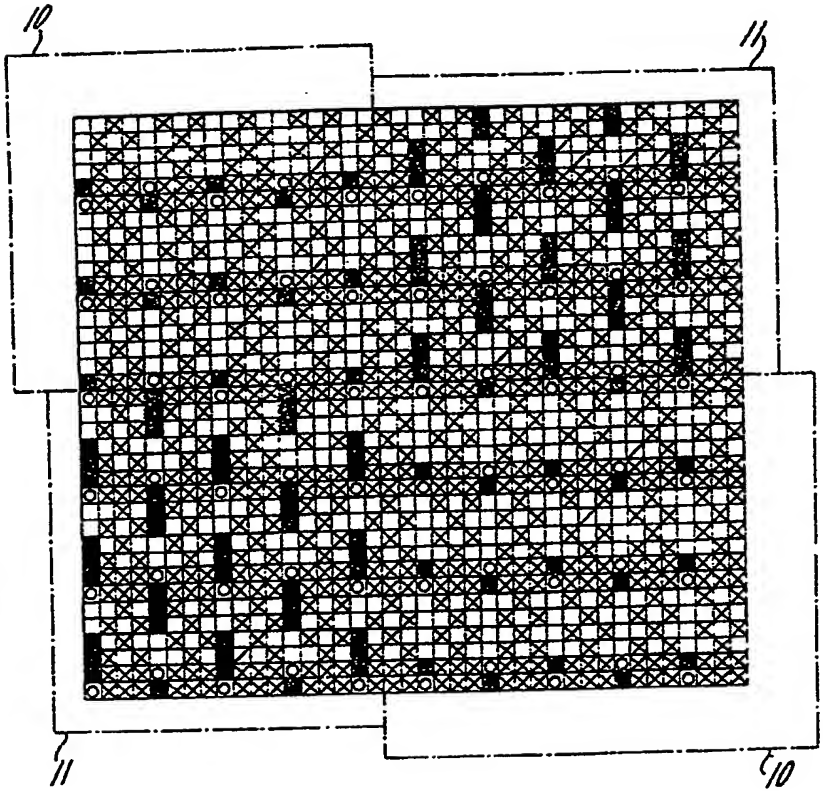


FIG. 5

851,192 COMPLETE SPECIFICATION
1 SHEET

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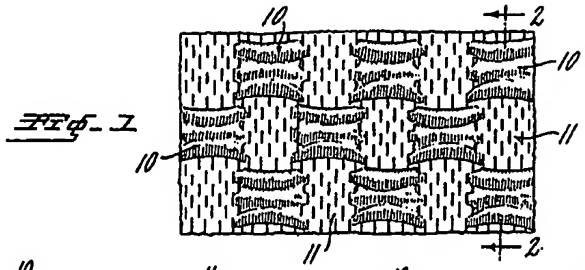

FIG. 1

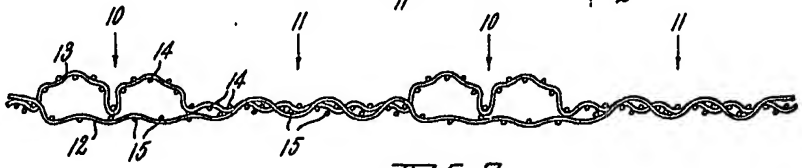

FIG. 2

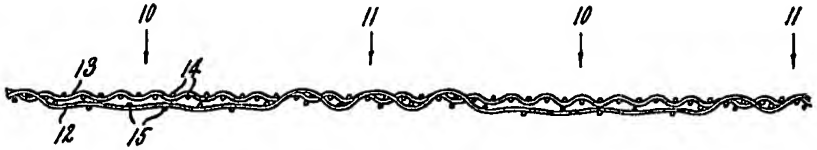

FIG. 3

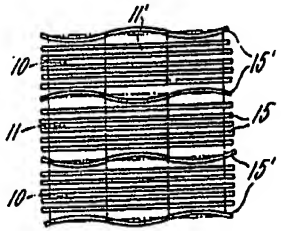

FIG. 4

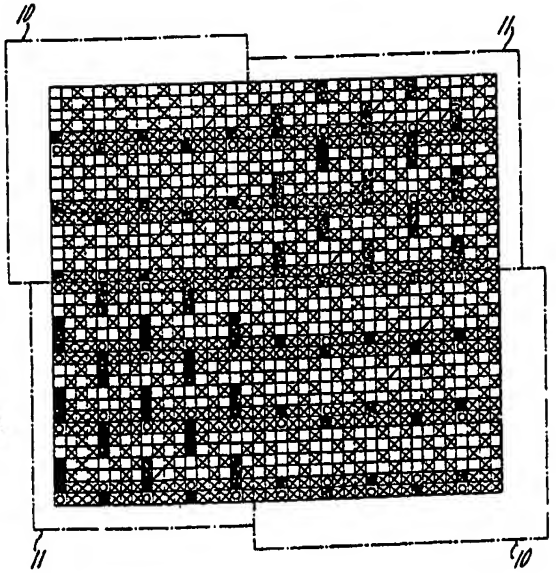

FIG. 5